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High Temperature Calibration Furnace System
User's Guide

(NASA-CR-196526) HIGH TEMPERATURE
CALIBRATION FURNACE SYSTEM USER'S
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The High Temperature Calibration Furnace System was designed and assembled by Summitec Corporation for the National Aeronautics and Space Administration (NASA), Marshall Space Flight Center in Alabama, under contract number NAS8-39351. We are located at 665 Emory Valley Road, Oak Ridge, TN 37380 and can be reached at telephone number (615) 482-6460 or fax (615) 482-1884. Summitec Corporation is a minority-owned and operated small business enterprise. Incorporated in 1987, Summitec Corporation offers consulting services in the fields of engineering, information management, and computer operations to both government and commercial clients. We, at Summitec, are dedicated to providing our clients with the highest degree of quality and support.

1.0 Introduction

The High Temperature Calibration Furnace System (HTCFS) was developed by Summitec Corporation. It is a high precision instrument providing a constant temperature which can be used to calibrate high temperature thermocouples. Incorporating the many recent technological advances from the fields of optical fiber thermometry, material science, computer systems interfacing and process control, the engineers at Summitec Corporation have been able to create a system that can reach a steady operating temperature of 1700°C. The precision for the system requires the measurement of temperature to be within 1°C in two hours and within 2°C in 24 hours. As documented, the experimental result shows that this system has been able to stay within .5 °C in 5 hours. No other systems commercially available have been able to achieve such high temperature precision.

This manual provides an overview of the system design, instructions for instrument setup, operation procedures. Also included are a vendor list and the source codes for the custom-designed software.

2.0 EQUIPMENT SETUP

2.1 System Design Overview

The HTCFS can calibrate high temperature thermocouples, ranging from 900°C to 1700°C. As shown in Figure 1, the HTCFS consists of a supervisory computer, power controller, furnace, refrigerated circulator, and low oxygen inert gas supply. The computer interacts with the power controller, which in turn provides the proper amount of electric power to heat the furnace. A constant supply of purging low oxygen inert gas provides an inert atmosphere within the furnace. The furnace itself is insulated with high temperature insulation material and an outer cooling jacket. The cooling agent (water) within the jacket is controlled by the refrigerated circulator to provide safety.

2.2 Furnace

As shown in Figure 2, the furnace is 20 cm in diameter by 15 cm long, housed in an aluminum barrel with stainless end caps. There are two circular insulation plates at each end of the barrel. These plates are made of 2.5 cm thick alumina based refractory, which can withstand 1700°C.

Sandwiched between these two insulation plates are layers of concentric materials. They are, from outside in, cooling copper tube, vacuum formed ceramic fiber insulation (alumina based), secondary heating element of Fe-Cr-Al (Kanthal A-1, 1200°C), ZYF zirconia fiber insulation, FBC thermal insulation (zirconia stabilized with yttria, 2000°C), and primary heating element of Pt-30Rh (1900°C).

In the center is the furnace core tube, which is made of high purity recrystallized alumina (1800°C). The tube is 23 cm (9 inches) long, 19 mm (3/4 inches) O.D. and 12.7 mm (1/2 inch) I.D and extends beyond the two insulation end plates. Within the furnace core tube, a tantalum block is inserted to serve as an isothermal block. This block, with a hole at each end, is designed to accept thermocouples from one side and an optical sensor from the other side. After the block is put in place, zirconia bushings are used to plug both ends.

The primary heating coil is wound around the core tube and surrounded by 2 concentric layers of zirconia for insulation. The secondary heating coil is wound around the outer layer of zirconia insulation and in turn, surrounded by a layer of vacuum-formed ceramic fiber. Finally, the copper cooling tube is wound around the ceramic fiber layer underneath the aluminum barrel.

The resistance of the primary heating coil is 1 Ohm at room temperature and the current requirement is 15 amperes. The resistance of the secondary heating coil is 12 to 13 Ohms at room temperature and its current requirement is 10 amperes. A B-type thermocouple is attached to the primary heating coil and a S-type thermocouple is attached to the secondary heating coil. These thermocouples monitor the coils' temperatures to prevent overheating and their extension wires are extended from the top of furnace with white and green connectors.

A stainless steel T-connector and flange adaptor attached to one end of core tube serves as a holder for the optic fiber sensor and as the inlet of the low oxygen inert gas flow. At the other end of the core tube, another flange adaptor is attached to accept the thermocouples to be calibrated.

2.3 Low Oxygen Inert Gas Supply System

The purpose of the inert gas supply system is to protect the tantalum isothermal block and thermocouples to be calibrated. The constant flow of inert gas, argon, is introduced from one end of the core tube to prevent their oxidation.

The components of this system consists of a supply of argon, an oxygen removal unit, and an oxygen partial pressure detector (Oxygemeter). The flow of argon gas is supplied from a cylinder via nylon tube to an oxygen removal unit and is regulated by a rotameter with a flow rate of 60 cc/minute. The gas is fed into a furnace at 500°C and then a reaction chamber. In this chamber, the oxygen in the argon gas reacts with a metallic magnesium chip and is depleted.

To ensure the proper operation of the system, the oxygen-purged argon is then led to another furnace, operated at 750°C. The oxygen partial pressure in the argon gas is continuously monitored by an indicator. When the partial pressure exceeds the level of 10^{-10} , the magnesium chip should be replaced.

Finally, the oxygen-purged argon enters the core tube at the end of the optic fiber thermometer, flows around the tantalum isothermal block and thermocouples. It is then discharged through the other end of the core tube.

2.4 Refrigerated Circulator

As stated above, the furnace barrel is insulated by a cooling jacket which serves as a safety shield to protect it from overheating. The cooling agent (water) is circulated from a refrigerated reservoir.

An Analog Constant Temperature Circulator (VWR Model 1141) holds a constant temperature bath, which is capable of maintaining a temperature range of -5°C to 100°C. The water is pumped through the tygon hose to one end of the copper tube, circulating around the furnace, and then returned to the reservoir via the other end of the copper tube.

2.5 Power Controller

The power controller consists of four major components: (1) optic fiber thermometer, (2) data acquisition processor, (3) power regulator, and (4) power circuitry.

2.5.1 Optic Fiber Thermometer

In the heart of the furnace temperature control is an optic fiber thermometer. The Luxtron Accufiber Model 10 has been chosen and is equipped with a 20 cm lightpipe as a thermosensor, 4 meters of optic fiber transmitter, menu tree panel, data processor, RS-232 serial port, and supporting software DUMBTERM.EXE and Accufiber Data Acquisition Program (ADAP). The temperature control process can be automated by a IBM-compatible PC through a RS-232 serial port. The Model 10 can also deliver a common analog output, ranging from 4 to 20 mA, to regulate an SCR power control unit, which in turn supplies the proper power to the primary heating coil.

When the Model 10 is powered on, it will run through a 15-second start-up and diagnostic sequence. The messages: "SELF TEST PASSED", "INITIATION", and then "CALIBRATING" will be displayed.

The Model 10 operating parameters can be set through the PC keyboard by running the program DUMBTERM or manually entered from the front menu tree panel. Because the PC is a single user/task computer, once it executes data collection, storage, and display commands, it will not be able to facilitate any operation parameter changes. Thus, in order to retain temperature control flexibility, the manual mode operation is recommended, i.e., enter the sensor data, control data, and alarm limit from the menu tree panel.

2.5.2 Data Acquisition Processor

A Microstar DAP 800/1 Series (DAP) board for the PC is used for data acquisition. This package includes an interface card, a termination board, a 50-line ribbon cable, and control software.

The DAP allows the PC to read analog voltage data from thermocouples, converts the voltage differentials into temperature readings, and generates analog and digital outputs for process control.

The termination board is mounted on the power control panel. It accepts eight pairs of thermocouples. The connectors from S0 to S7 are assigned to the secondary heating element, the primary heating element, cooling fluid, four testing thermocouples and a cold junction compensation, respectively. When connectors S3 through S6 are not in use, jumpers must be applied to ground the particular connector.

The termination board has 64 quick and secure connection joints. The connection to the PC requires an MSCBL 030-01 ribbon cable from Microstar. The digital output connections are labeled DO0 through DO7, each with its own corresponding ground (GND) connection. Two of the digital outputs, DO0 and DO1, are assigned to control the solid state relays.

The output voltage for digital "1" is at least 2.6 Volts and the output voltage for the "0" is no more than 0.5 Volt, both of which are used to trigger the Solid State Relays. When making the ribbon cable connections, the black wire should be connected to DO0, the yellow wire to its GND, the red wire to DO1, and the green wire to its GND, in that order.

2.5.3 Power Regulator (SCR)

The role of the Phasetronics SCR power regulator is to control the ac power directed to the primary heater. The controller consists of power semi-conductors, a heat sink, trigger circuitry and fuse. This power regulator receives conventional milliamp input (4-20 mA dc) from the Luxtron-Accufiber Model 10 furnace temperature controller to determine the amount of output electricity. The maximum output of this regulator is set at 24 volts and 15 amperes. By regulating the temperature controller, the output, however, can also be partial.

2.5.4 Power Circuitry

The power circuitry is illustrated in Figures 3 and 4. All buttons and switches on the front panel are clearly identified. On the front panel is a push and release power-on switch. To the right are two pilot lights, one for the primary heating coil and one for the secondary heating coil. When the power is supplied to the heating coils, the corresponding light will turn on. Also on the front panel is a mushroom-type emergency switch. In case of an emergency, the power to the whole system can be shut off by pushing this button. The computer

and monitor, however, will not be affected by the emergency shut off and will continue monitoring the temperature of the heating coils. The power-on and emergency switches are designed such that after an emergency shut down, the power system has to be restarted manually.

2.6 SUPERVISORY COMPUTER (386DX-33MHz)

An 386DX-33MHz PC is equipped with a Bernoulli Drive (Insider 150 manufactured by Iomega) and a 9-pin dot matrix printer. The computer system is loaded with a data acquisition card that can manage the entire data acquisition and data storage, and can perform the control processes by a customized software. The system can also be automated to interface, monitor, and control the furnace operations.

3.0 OPERATING PROCEDURES

The operation procedures for the High Temperature Calibration Furnace System are only guidelines to providing a safe operation environment, obtaining the stability of optic fiber thermometry, collecting, storing and displaying the results of experiment, and maximizing the equipment life and utilization. The items presented below make up a benchmark checklist. With experience, operators of the system may wish to include additional benchmarks.

Before the system can be started, a 120 VAC power line with 30 amperes capacity must be in place. In addition, 3.75 liters (1 gallon) of chilling fluid must be available in the refrigerated circulator and a pure argon gas cylinder must be safely secured. A PC computer at room temperature is acceptable to host the system.

3.1 Pre-Power Up Linkage:

1. Computer to Monitor and Printer.
2. Computer to Data Acquisition Processor (DAP) board.
3. Computer to Optic Fiber Thermometry (RS-232).
4. Cooling Hoses from Refrigerated Circulator to Furnace.
5. Argon Tubing from Cylinder through Oxygometer to Furnace.
6. Optic Fiber Cable from Accufiber unit to Lightpipe.
7. Inserts to Furnace Core Tube:
 - a. Tantalum Isothermal block
 - b. Ceramic Bushings
 - c. Optic Fiber Lightpipe
 - d. Thermocouples with Insulator
 - e. Argon tube to Stainless Steel Fitting
8. Thermocouple Connections to DAP termination Board:
 - a. S-type for Secondary Heater to S0
 - b. B-type for Primary Heater to S1
 - c. K-type (?) for Cooling Tube to S2
 - d. Thermocouples or Jumpers to S3 through S6
 - e. Cool Junction Compensation at S7
9. Power Linkage:
 - a. Computer, Monitor and Printer
 - b. Accufiber Optic Fiber Thermometry
 - c. Inert Gas Regulator
 - d. Refrigerated Circulator
 - e. Primary and Secondary Heaters to Power Controller
 - f. Power Controller

3.2 Power On Sequences:

1. Source of Electricity

2. Inert Gas Regulator
3. Refrigerated Circulator
4. Accufiber Optic Fiber Thermometry
5. Printer, Monitor and Computer

3.3 Experiment Procedures:

3.3.1 Inert Gas Oxygen Removal Unit:

- a. Secure all tubing from air leakages.
- b. Turn on gas and regulate to less than 0.7 atm (10 Psi).
- c. Stabilize argon flow rate (30 to 35 mm, 60 cc/min).
- d. Purge the system for five minutes and observe Oxygometer reading (-14)

3.3.2 Refrigerated Circulator:

- a. Insert thermometer into the lid of reservoir.
- b. Clear thermometer one inch from the bottom.
- c. Set temperature to 10°C.
- d. Set limit adjust knob to cut-off point at 30°C.
- e. Switch unit ON to start operation.
- f. Observe fluid temperature to reach set point.

3.3.4 Furnace Thermocouple Insertion and Connection to DAP Board:

- a. Take notes on all thermocouples inserted.
- b. Secure all connections in correct terminals.
- c. Verify +/- ends of thermocouples in place.
- d. Insert jumpers in unused slots.

3.3.5 Accufiber Optic Fiber Thermometry: (Manual Sec. 3)

- a. Enter Fixed Set-Point or First Set-Point of Step Scan.
- b. Follow Menu Tree (p. 25), enter Sensor Factors:
 - Type: Lightpipe
 - Factor: 4.77 (provided)
 - Bandwidth: 10 Hz (suggested)
 - Gain: auto (suggested)
 - Emissivity: 1
 - Sensor Calib.: 400°C
- c. Alarm Limits:
 - Maximum: 1650°C (<1900°C)
 - Minimum: 800°C
 - Rate: Sync with Ramp (suggested < 100°/Min)
- d. Control Data: (empirical suggestions for this system)

Fixed Setpoint: (as 3.3.5.a)

Prop Band : 5 %

Integral: 1 Min

Derivative: 0.2 Min

Ramp: 50°/Min

Max. Power: 10 % (starts at low %, then adjusted)

Auto/Manual: auto

Control Type: Simple (step scan, follow programmable)

e. Miscellaneous:

Serial Port:

Sampling Intervals: 10 seconds (not < 6 seconds)

Handshake: Hardware

Baudrate: 9600

Parity: none

Data bits: 8

Stop bits: 1

System Information:

Input Board: Serial # 2314, Temp Limit 400°C to 1900°C

Output Board: Serial # 3304, Output Type I

Digital Board: Firmware Ver. 2.70, EE ROM Ver. 2

f. Record all these data on Channel Input Setup Page (D-8)

3.3.6 In-House Software:

a. Type C:>CD qb

b. Execute HISCAN:

Specify file path and name for data storage,
Enter sampling interval (just for record here),
Designate thermocouples,
Start collecting blank data for one minute,
Energize the power to heaters.

3.3.7 Power Control Panel

- Switch 120 VAC with 30 amperes power source.
- Press POWER-ON switch (square light on).
- Observe SECONDARY-HEATING-COIL light on.
- Observe development of heating process on monitor.
- Expect to complete a successful experiment.

3.3.8 Operating Conclusion

- Press EMERGENCY-STOP when heating is not require.
- Keep chilled fluid running until furnace cooled.
- Keep inert gas running.
- Dissemble optic fiber assemblies only when it is cooled.

- e. Conclude HISCAN when cooling history is not needed.

3.3.9 Experimental Results

Test runs on this system has generated excellent results. These results are included in files under the directory C:>\qb\ *.DAT. Some of the figures are photographed and included in attached pictures. These pictures demonstrate the excellent specification this system is providing. In one of the pictures, the set-point was at 1250°C, the temperature of optic fiber had stayed within half of a degree for five hours. For more details, it would be demonstrated on monitor by executing HILOT program.

4.0 Custom-Designed Software

Summitec has developed two custom-designed BASIC programs to facilitate the operation of the calibration furnace. The first program, HISCAN, is a program that allows for the acquisition of data from the optic fiber thermometer and thermocouples being calibrated, the storage of the data onto a user-specified file directory, and the display the real time data profile. The second program, HIPLOT, reads the data from a specified directory and plots the data profile onto a screen.

These programs integrate the facilities of MicroSoft QuickBasic, Quinn-Curtis QuickBasic, MicroStar DAPL software and AcuFiber interface and are customized for these specific applications. The programs, compiled as executable .EXE files, are loaded in the computer and are ready for immediate use. The source codes are listed in Appendix E.

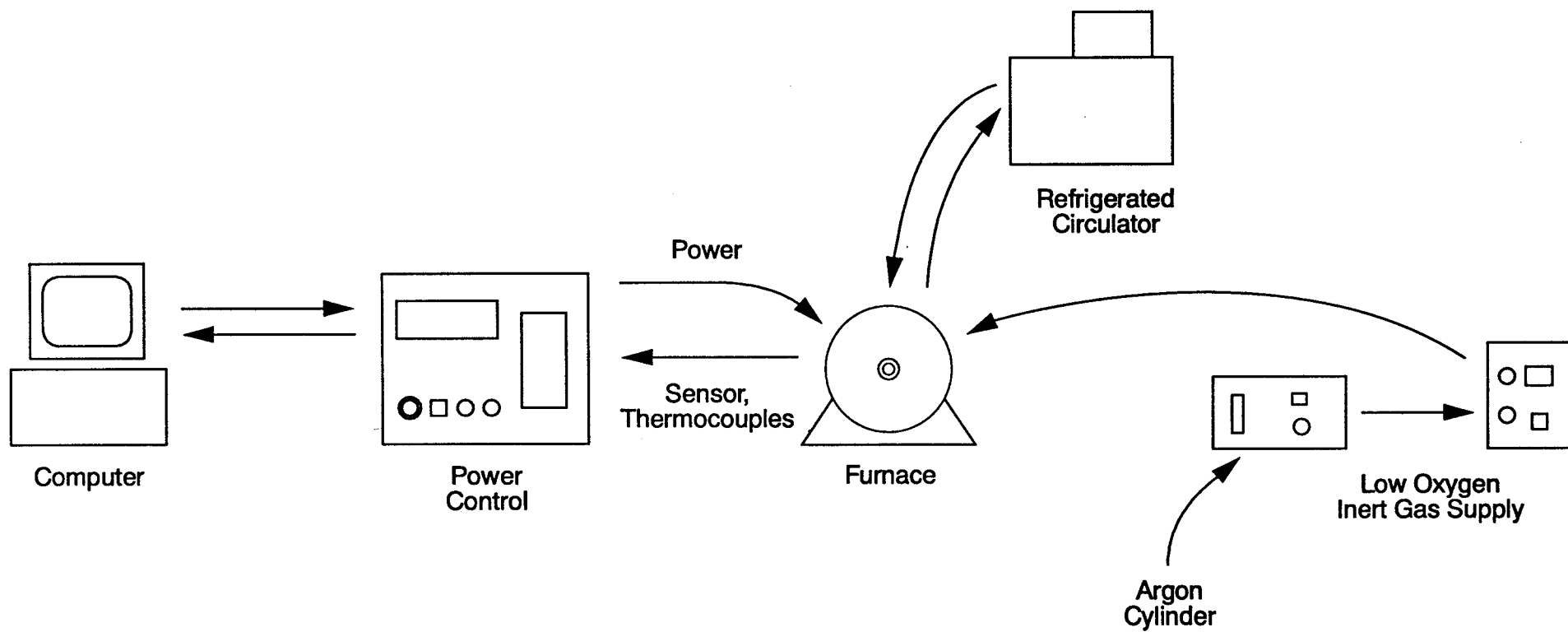


Figure 1 High Temperature Calibration Furnace System

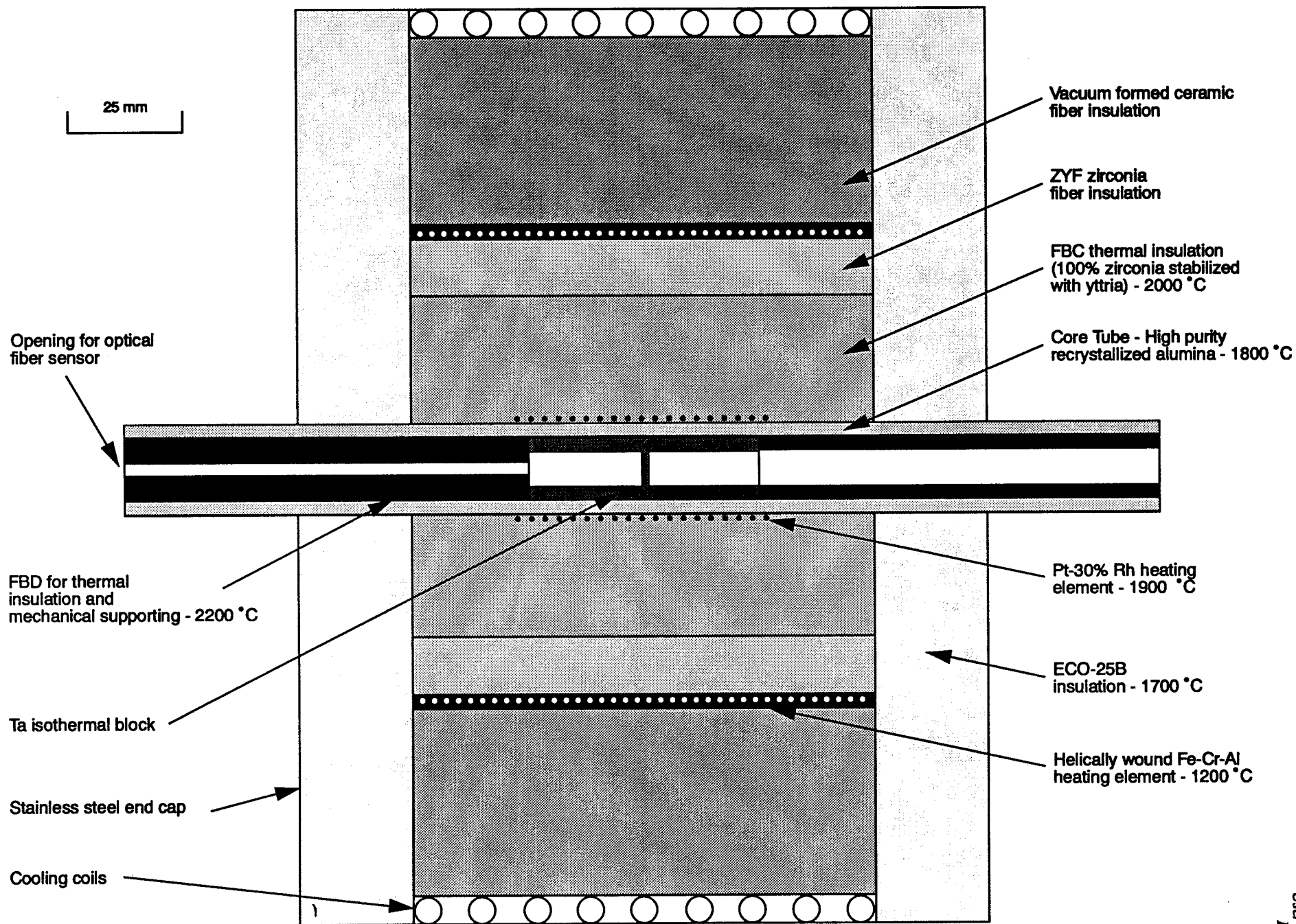


Figure 2 High Temperature Calibration Furnace - Cross Section

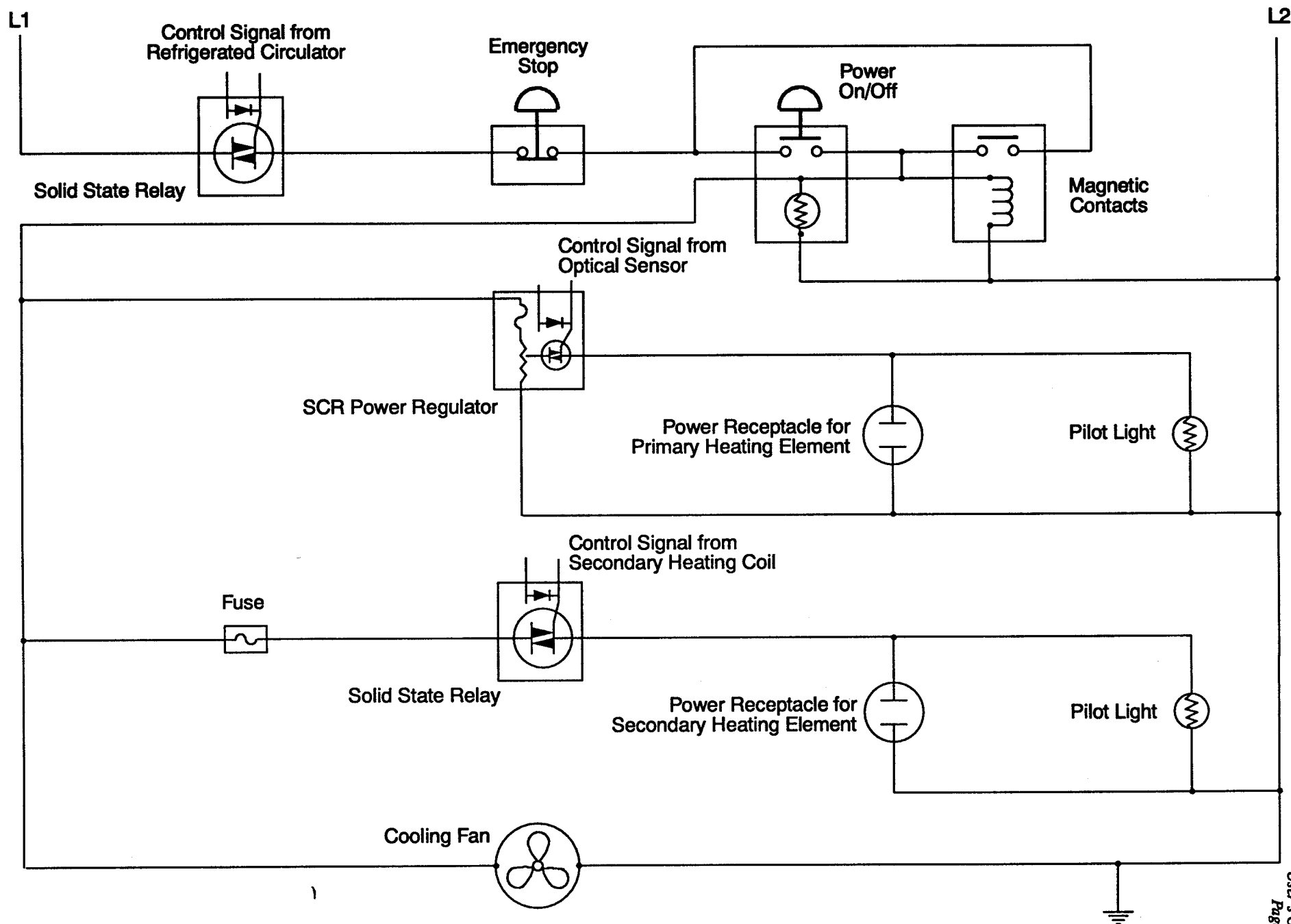
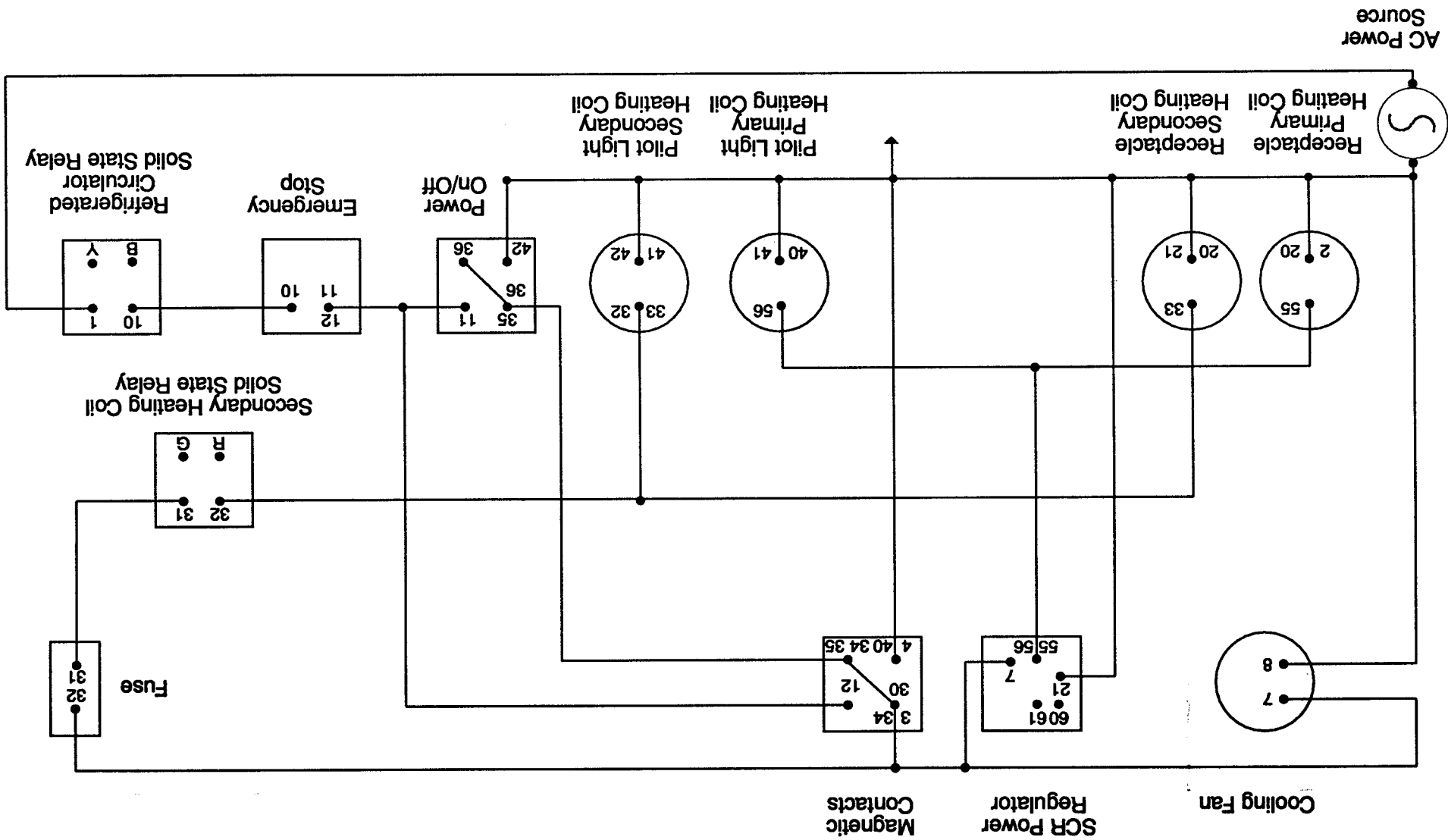


Figure 3 Schematic Diagram

Figure 4 Wiring Diagram



Appendix A MANUAL LIST

Summitec - High Temperature Calibration Furnace System - User's Guide

Microsoft MS-DOS 5.

Microsoft QuickBasic for DOS System, Version 4.5.

Quinn-Curtis: Science and Engineering Tools for QuickBasic IPC-QB-006, Version 8.0.

Samtron monitor - User's Manual

Star NX-1001 multi-font dot matrix printer, User's Manual

Iomega: Open Architecture Drive (OAD) for DOS

Owner's Manual

Setup and Reference Guide

Insider 150 - Installation Guide & User's Reference

Microstar Laboratories, Inc.: Data Acquisition Processor

System Manual,

Hardware Manual,

Application Manual, and

DAPL manual

Luxtron: Accufiber Model 10

High Temperature Measurement and Control System - User's Manual, version 2.35.

Accufiber Data Acquisition Program (ADAP) - User's Manual, version 1.0.

VWR Scientific - Analog Constant Temperature Circulator, Instruction Manual

Phaselectronics: SCR - Operation & Services Manual

Omega: Solid State Relay (SSR) - Operator's Manual

Appendix B **HARDWARE LIST**

- a) **Supervisory Computer:**
386DX-33MHz CPU IBM compatible PC with standard keyboard and mouse
Samtron 36 cm (14") SVGA monitor
Star Nx-1001 mufti-font dot-matrix printer
Iomega 150 Insider MultiDisk with SICS adapter and MultiDisk tripak
Microstar DAP 800/1 processor (SN 48394), 50 line ribbon cable, and Termination board-MSTB005-02 (SN 40351)

- b) **Power Controller:**
Luxtron: Accufiber Model-10
 Furnace temperature controller
 20 centimeters Lightpipe sensor (#73245)
 4 meters flexible optic fiber cable (#62595).
Phaselectronics: SCR power controller (IPC120-20 E)
Magnetic switch(1)
Terminal block rated 30 amperes(1)
Heat sink(2)- Omega part # FHS-1
Solid state relays(2) - Omega part # SSRDC45, SSRDC10
Pilot lights (2) - indicators for heating coils
Emergency stop button(1)
Power switch(1)
Fuse(1)-Omega part # KAX-10
Receptable(2) and power cord(2)
Exhaust fan(1)

- c) **Furnace Assemblies:**
Furnace
B-type and S-type thermocouple extension wires
Isothermal tantalum block and Ceramic Inserts
Flanges adapter(3)

- d) **Inert Gas Regulator:**
Pure argon gas supply (in cylinder, self-supplied)
Brass argon gas regulator (self-supplied)
Oxygen purging unit with rotameter for argon flow rate
Oxygemeter H100 (oxygen partial pressure indicator)
Nylon tubes with Stainless steel fittings

- e) **Refrigerated Circulator:**
Analog Constant Circulating Bath (VWR Model 1141 SN 309666)
Thermometer and hoses (2)

Appendix C Software List

Microsoft MS-DOS 5, 9 cm (3.5") disks (3).

Microsoft QuickBASIC, Version 4.5 for MS-DOS, 9 cm (3.5") disks (2).

Quinn-Curtis, Science & Engineering Tools for Microsoft QuickBASIC 4.X, Version:IPC-QB-006, 9 cm (3.5") DISK (1) and 13 cm (5.25") disk (1).

Luxtron Accufiber ADAP software version 1.0, 13 cm (5.25") disk (1).

Microstar Laboratories, Inc.: Data Acquisition Processor, Software version 4.2, 9 cm (3.5") disks (2) and 13 cm (5.25") disk (2).

Iomega: Open Architecture Driver (OAD) for DOS, OAD release 1.21.00, 9 cm (3.5") disk (1).

Summitec: High Temperature Calibration Furnace System in-house software and experiment data, 9 cm (3.5") disk (1)

Appendix D Vender/Supplier List

Luxtron Accufiber-Luxtron, Model 10:

Luxtron Corporation
9550 S.W. Nimbus Avenue
Beaverton, OR 97005
(615) 626-1700

Data Acquisition Processor System, DAP 800/1:

Microstar Laboratories, Inc.
2265 116 Avenue N.E.
Bellevue, WA 98004
(206) 453-2345

SCR Power Controller (20 amp single-phase), #IP1-1220-E:

Phasetronics Inc.
13214 38th Street N.
P.O. Box 17159
Clearwater, FL 34622-0159
(813) 573-1900, FAX (813) 573-1803

Cabinet, EC9906BT; 19" Aluminum Panel Board (2), PA1108WH:

RS-Electronics-Huntsville
555 Sparkman Drive
Huntsville, AL 35816
(205) 721-9999

Nameplate:

Delta Awards & Signs
1645 Downtown West Blvd.
Knoxville, TN 37919
(615) 694-001 or (615) 694-0777

Plastic Window Cover:

Commercial Plastics & Supply Corp.
918 Katherine Avenue
Knoxville, TN 37921
(615) 637-1000 or (800) 831-4816

Analog Constant Temperature Circulator, #1141:

VWR Scientific
161 Mitchell Road
Oak Ridge, TN 37830
(615) 481-0874

Argon Two Stage Regulator, UPE-3-75-580

National Welders
5006 Middlebrook Pike
Knoxville, TN 37921-5907
(615) 584-6390

Electric Parts:

20 Amp 125V 3W Twist-Lock Receptacle, #Levion 2310; Male Plug 20A 125V 3W, #Levion 2311:

Roden Electric Co.
745 Emory Valley Road
Oak Ridge, TN 37830
(615) 482-4906

Emergency Stop Pushbutton, #50F7339; Contact Block, #50F7321.

Newark Electronics
5401-A Kingston Pike
Knoxville, TN 37919
(615) 588-6493

Solid State Relay, SSR240 DC10 and SSR240 DC45; Finned Heat Sink, FHS-2; Bassman Fuse, KAX-10; Fuse Block, FB-1.

Omega Engineering, Inc.
One Omega Drive
Box 4047
Stanford, CT 06907
(203) 359-1660

10 cm (4") Axial Fan Guard, #4C657; Unit Bearing Axial Fan, #4C686; 22mm Indicating Light, #5A625; Indicating Light Lens (Red), #5A642; 22mm Square Pushbutton, #6P170; 22mm Pushbutton Lens (Red), #6P201; 14 Gauge Wire, #6X794; DP Magnetic Contactor 25FLA, #1A636.

W.W. Grainger, Inc.
6500 Baum Drive
Knoxville, TN 37919
(615) 588-2956

Summitec Corporation

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Terminal Block 30amp, #22012

Industrial Electronics, Inc.
7209 Chapman Highway
Knoxville, TN 37916

Appendix E Custom-Designed Software Programs

Appendix E.1 HISCAN

```
' HISCAN.BAS ( Originated from NEW.BAS )
',
' This program is the first of two programs prepared by Summitec
' Corporation to accompany the High Temperature Calibration Furnace
' System. Based on QuickBASIC, this program integrated the data
' acquisition software of DAPL, temperature control commands of Luxtron
' AccuFiber Model 10 software, and Quinn-Curtis IPC-QB-006 Science and
' Engineering Graphic Library into a consolidated application program.
' This program also illustrates the dual communications with the DAP and
' the Luxtron Model 10 by using QuickBASIC textfile I/O to write
' commands to and read data from the DAP and the Luxtron Model 10.
',
' This program inquires the temperature information via optical fiber
' and thermocouple, stores the data on hard disc and simultaneously
' display the real time data on graphic screen. This program does not
' control the furnace operation, but will advance the screen to display
' the continuation of data collection.
',
'$INCLUDE: 'DAPIO.INC'
',
'$INCLUDE: '\qb006\GRAFTYPE.BAS'
',
DECLARE SUB GetMaxCoords (X%, y%)
DECLARE SUB DefGraphWindow (x1%, y1%, x2%, y2%, win%)
DECLARE SUB selectcolor (c%)
DECLARE SUB InitSEGraphics (mode%, plotmode%)
DECLARE SUB SetCurrentWindow (win%)
DECLARE SUB ClearWindow ()
DECLARE SUB SetAxesType (PlotTypeX%, PlotTypeY%)
DECLARE SUB SetViewBackground (c%)
DECLARE SUB ScalePlotArea (x1!, y1!, x2!, y2!)
DECLARE SUB SetXYIntercepts (x1!, y1!)
DECLARE SUB DrawXAxis (TicSpace!, dir%)
DECLARE SUB LabelXAxis (NthTic%, dir%)
DECLARE SUB LabelXAxisWithStrings (NthTic%, TicStrings$, NumStrings%, dir%)
DECLARE SUB DrawYAxis (TicSpace!, dir%)
DECLARE SUB LabelYAxis (NthTic%, dir%)
DECLARE SUB LabelYAxisWithStrings (NthTic%, TicStrings$, NumStrings%, dir%)
DECLARE SUB LinePlotData (datax!(), datay!(), numdat%, newcolor%, linestyle%)
DECLARE SUB ScatterPlotData (xdata!(), ydata!(), numdat%, scatcol%, markType%)
DECLARE SUB TitleWindow (wintitle$)
DECLARE SUB TitleXAxis (Xtitle$, dir%)
```

```

      ONOFF$(X%) = "ON "
    ELSE
      ONOFF$(X%) = onofftemp$ + RIGHT$(ONOFF$(X%), LEN(ONOFF$(X%)) - LEN(onofftemp$))
    END IF
  ELSE
    ONOFF$(X%) = onofftemp$
  END IF
END IF
LOOP UNTIL ONOFF$(X%) = "OFF" OR ONOFF$(X%) = "ON "
LOCATE 8 + X%, 20
PRINT ONOFF$(X%)
IF ONOFF$(X%) = "ON " THEN
  LOCATE 8 + X%, 32
  TCTYPE$ = ""
  IF TCTYPE$ <> "" THEN
    TCTYPE$(X%) = tctypetemp$
  END IF
  IF TCTYPE$(X%) >= "0" AND TCTYPE$(X%) <= "9" THEN
    LOCATE 8 + X%, 44
    TCIDTEMP$ = ""
    IF TCIDTEMP$ < 20 THEN
      TCIDTEMP$(X%) = tcidtemp$ + RIGHT$(TCID$(X%), LEN(TCID$(X%)) - LEN(tcidtemp$))
    END IF
    TCIDTEMP$(X%) = tcidtemp$
  END IF
  LOCATE 8 + X%, 5
  PRINT "The above data correct?(Y/N) ", Correct$
  LOCATE 8 + X%, 5
  PRINT "TE, black"
  LOCATE 8 + X%, 5
  PRINT "
Correct$ = "Y" OR Correct$ = "y"

'Specify Data Range for Screen Display
'Number of sampling intervals per screen ( 0 to ngap )
'Number of intervals advanced per page
'Beginning interval of a page ( advanced by ndip )
15 'Initial maximum plotting temperature
'Initial minimum plotting temperature
+ 1 'Dimension size for data arrays

```



```

DIM xdata(0 TO nt)
DIM ydata0(0 TO nt)
DIM ydata1(0 TO nt)
DIM ydata2(0 TO nt)
DIM ydata3(0 TO nt)
DIM ydata4(0 TO nt)
DIM ydata5(0 TO nt)
DIM ydata6(0 TO nt)
DIM ydata3t(0 TO nt)
DIM ydata4t(0 TO nt)
DIM ydata5t(0 TO nt)
DIM ydata6t(0 TO nt)
DIM accufi(0 TO nt + 1)
DIM xlabel$(0 TO 5)
DIM ylabel$(0 TO 5)

```

```
accufi(0) = 400
```

```
accufi(1) = 400
```

```
TEMPS = ""
```

```
'Store Header for output datafile
```

```
OPEN File$ FOR OUTPUT AS #3 ' diskfile for output
```

```
PRINT #3, "Sampling time interval: " + interval$
```

```
PRINT #3, " "
```

```
PRINT #3, "Thermocouple Parameters"
```

```
PRINT #3, " "
```

```
PRINT #3, "Channel    On/Off    T/C TYPE    T/C ID"
```

```
PRINT #3, "-----    -----    -----    -----"
```

```
FOR X% = 0 TO 7
```

```
PRINT #3, "S" + LTRIM$(STR$(X%)) + "          " + ONOFF$(X%) + "          " + TCTYPES$(X%) + "
          " + TCIDS$(X%)
```

```
NEXT X%
```

```
PRINT #3, " "
```

```
PRINT #3, "Code Thermocouple Type"
```

```
PRINT #3, "  0-Type E    3-Type R    6-Type N    9-Type B"
```

```
PRINT #3, "  1-Type J    4-Type S    7-Type U"
```

```
PRINT #3, "  2-Type K    5-Type T    8-Type L"
```

```
PRINT #3, " "
```

```
'Initiate SE Graphic Screen
```

```
CALL InitSEGraphics(-3, 0)
```

```
CALL GetMaxCoords(maxX%, maxY%)
```

```
CALL DefGraphWindow(1, 1, maxX%, maxY% * 5 / 6, win2)
```

```
CALL DefGraphWindow(1, maxY% * 5 / 6 + 1, maxX%, maxY%, win3)
```

```
CALL BorderCurrentWindow(YELLOW)

CALL NInitDap("C:ACCEL0")      'Establish DAP communication
                                'Configure DAP by using
                                'DAPL command file DISPLAY.DAP
CALL SetParam(1, TCTYPE$(3))
CALL SetParam(2, TCTYPE$(4))
CALL SetParam(3, TCTYPE$(5))
CALL SetParam(4, TCTYPE$(6))
                                'Call "Display1.dap"

IF ConfigDap%(1, "DISPLAY1.DAP") >= 200 THEN
  PRINT "Error while configuring DAP."
  END
END IF

WHILE IOCTL$(2) = "0"          'Waiting for response
WEND
luxtron$ = ""
OPEN "COM1:9600,n,8,1,asc" FOR INPUT AS 10

FOR K = 1 TO 5
NEXT K

                                'Initiate Graphic Window
                                'Real Time Display of Data Acquisition
nn = (ymax - ymin) / 25      'Plot range from (0, 0) to (ngap, ymax)
FOR jj% = 0 TO 5
  xlabel$(jj%) = STR$(INT(nset + jj% * 5)) + " "
  ylabel$(jj%) = STR$(INT(ymin + jj% * 5 * nn))
NEXT jj%

CALL SetCurrentWindow(win2)
CALL ClearWindow
CALL SetAxesType(AXLINEAR, AXLINEAR)
IF (NOT MonoCRT%) THEN CALL SetViewBackground(black)
CALL ScalePlotArea(nset!, ymin!, nset + ngap!, ymax!)
CALL SetXYIntercepts(nset!, ymin!)
CALL selectcolor(WHITE)
CALL DrawXAxis(ngap / 25!, AXBOTTOM)
CALL LabelXAxisWithStrings(5, xlabel$, 6, AXBOTTOM)
CALL DrawYAxis(nn!, AXLEFT)
CALL LabelYAxisWithStrings(5, ylabel$, 6, AXLEFT)
CALL selectcolor(WHITE)
CALL TitleWindow("Raw Data file : " + File$)
CALL TitleXAxis("Number of Sampling, interval = " + interval$, AXBOTTOM)
CALL TitleYAxis("Temperature in Celsius", AXLEFT)
```

```
dold$ = DATES$  
dnew$ = dold$  
told$ = TIMES$  
tnew$ = told$
```

```
I = 0           'Data Collection  
m = 0           'Real Time Graphic Display  
               'Data Storage
```

```
DO              'Loop waiting for "Q" or "q" to stop
```

```
I = I + 1  
m = m + 1
```

```
               'Fetch AccuFiber for Optical Data
```

```
luxtron$ = ""
```

```
IF NOT EOF(10) THEN
```

```
  TEMP$ = TEMP$ + INPUT$(LOC(10), #10)
```

```
  DO
```

```
    IF INSTR(TEMP$, "C") = 0 THEN
```

```
      IF UCASE$(INKEY$) = "Q" THEN
```

```
        GOTO start
```

```
      END IF
```

```
      DO              'Fetch DAP for Thermocouple Data
```

```
        INPUT #2, y0, y1, y2, Y3, Y4, Y5, Y6, Y7
```

```
        LOOP UNTIL LOC(2) <= 16
```

```
        TEMP$ = TEMP$ + INPUT$(LOC(10), #10)
```

```
      END IF
```

```
    LOOP UNTIL INSTR(TEMP$, "C") <> 0
```

```
    t$ = TIMES$           'Time data collected
```

```
    Hr = VAL(t$)
```

```
    IF Hr < 12 THEN Ampm$ = " AM" ELSE Ampm$ = " PM"
```

```
    IF Hr > 12 THEN Hr = Hr - 12
```

```
    PRINT #3, " "
```

```
    PRINT #3, " "
```

```
    PRINT #3, STR$(I) + ": The time is" + " " + dnew$ + " " + tnew$
```

```
    PRINT #3, y0; y1; y2; Y3; Y4; Y5; Y6; Y7
```

```
    luxtron$ = LEFT$(TEMP$, INSTR(TEMP$, "C"))
```

```
    TEMP$ = MID$(TEMP$, INSTR(TEMP$, "C") + 1)
```

```
    PRINT #3, " " + RIGHT$(luxtron$, 13)
```

```
    luxtron$ = RIGHT$(LEFT$(RIGHT$(luxtron$, 11), 9), 7)
```

```
    dnew$ = DATES$
```

```
    tnew$ = TIMES$
```

```
  END IF           'End of ONE data
```

```

                                'Start data processing
accufi(m) = VAL(luxtron$)
xdata(m) = I
ydata0(m) = y0
ydata1(m) = y1
ydata2(m) = y2
ydata3t(m) = Y3                                'Testing graphic screen ceiling
ydata3(m) = Y3
IF Y3 > ymax THEN ydata3(m) = ymax
ydata4t(m) = Y4
ydata4(m) = Y4
IF Y4 > ymax THEN ydata4(m) = ymax
ydata5t(m) = Y5
ydata5(m) = Y5
IF Y5 > ymax THEN ydata5(m) = ymax
ydata6t(m) = Y6
ydata6(m) = Y6
IF Y6 > ymax THEN ydata6(m) = ymax

IF m >= nt THEN                                'End-of-Page testingm reaches ngap+1,
n = ndip                                        'm = ngap + 1, define n = ndip
FOR u% = 0 TO nt - n                            'retain data: from ( nset + ndip )
    xdata(u%) = xdata(u% + n)                    '          to ( nset + nt )
    ydata0(u%) = ydata0(u% + n)
    ydata1(u%) = ydata1(u% + n)
    ydata2(u%) = ydata2(u% + n)
    ydata3(u%) = ydata3t(u% + n)
    ydata4(u%) = ydata4t(u% + n)
    ydata5(u%) = ydata5t(u% + n)
    ydata6(u%) = ydata6t(u% + n)
    ydata3t(u%) = ydata3t(u% + n)
    ydata4t(u%) = ydata4t(u% + n)
    ydata5t(u%) = ydata5t(u% + n)
    ydata6t(u%) = ydata6t(u% + n)
    accufi(u%) = accufi(u% + n)
NEXT u%

m = nt - ndip

ymax% = ymax * 3 / 5                            'Searching for Max and Min Y Range
ymin% = ymax / 5

IF ONOFF$(3) = "ON " THEN
    ymax% = ydata3(nt - n)
    ymin% = ydata3(0)
ELSEIF ONOFF$(4) = "ON " THEN

```

```
    ymax% = ydata4(nt - n)
    ymin% = ydata4(0)
ELSEIF ONOFF$(5) = "ON " THEN
    ymax% = ydata5(nt - n)
    ymin% = ydata5(0)
ELSEIF ONOFF$(6) = "ON " THEN
    ymax% = ydata6(nt - n)
    ymin% = ydata6(0)
END IF

IF ONOFF$(3) = "ON " THEN
    FOR mm% = 0 TO (nt - n)
        IF ydata3(mm%) > ymax% THEN ymax% = ydata3(mm%)
        IF ydata3(mm%) < ymin% AND ydata3(mm%) > 0 THEN ymin% = ydata3(mm%)
    NEXT mm%
END IF

IF ONOFF$(4) = "ON " THEN
    FOR mm% = 0 TO (nt - n)
        IF ydata4(mm%) > ymax% THEN ymax% = ydata4(mm%)
        IF ydata4(mm%) < ymin% AND ydata4(mm%) > 0 THEN ymin% = ydata4(mm%)
    NEXT mm%
END IF

IF ONOFF$(5) = "ON " THEN
    FOR mm% = 0 TO (nt - n)
        IF ydata5(mm%) > ymax% THEN ymax% = ydata5(mm%)
        IF ydata5(mm%) < ymin% AND ydata5(mm%) > 0 THEN ymin% = ydata5(mm%)
    NEXT mm%
END IF

IF ONOFF$(6) = "ON " THEN
    FOR mm% = 0 TO (nt - n)
        IF ydata6(mm%) > ymax% THEN ymax% = ydata6(mm%)
        IF ydata6(mm%) < ymin% AND ydata6(mm%) > 0 THEN ymin% = ydata6(mm%)
    NEXT mm%
END IF

' "#3", ans$          'Reset Graphic Screen
CALL SetCurrentWindow(win2) 'Plot Range from (nset, ymin)
CALL ClearWindow           , to (nset+ngap, ymax)
CALL SetAxesType(AXLINEAR, AXLINEAR)
IF (NOT MonoCRT%) THEN CALL SetViewBackground(black)

yspan = ymax% - ymin%
yspan10% = INT(yspan / 10) + 1
```

```
yspan% = yspan10% * 10
ymin5 = ymin% / 5
ymin% = INT(ymin5) * 5
```

```
ymin = ymin% - yspan% / 2
ymax = ymin% + yspan% * 2
nn = (ymax - ymin) / 25
nset = nset + ndip
```

```
FOR jj% = 0 TO 5
  xlabel$(jj%) = STR$(INT(nset + jj% * 5)) + " "
  ylabel$(jj%) = STR$(INT(ymin + jj% * 5 * nn))
NEXT jj%
```

```
CALL ScalePlotArea(nset!, ymin!, nset + ngap!, ymax!)
CALL SetXYIntercepts(nset!, ymin!)
CALL selectcolor(WHITE)
```

```
CALL DrawXAxis(ngap / 25!, AXBOTTOM)
'CALL LabelXAxis(5, AXBOTTOM)
CALL LabelXAxisWithStrings(5, xlabel$, 6, AXBOTTOM)
```

```
CALL DrawYAxis(nn!, AXLEFT)
'CALL LabelYAxis(5, AXLEFT)
CALL LabelYAxisWithStrings(5, ylabel$, 6, AXLEFT)
```

```
CALL selectcolor(WHITE)
CALL TitleWindow("Raw Data file : " + File$)
CALL TitleXAxis("Number of Sampling, interval = " + interval$, AXBOTTOM)
CALL TitleYAxis("Temperature in Celsius", AXLEFT)
```

```
END IF 'Terminate End-of-Page testing
```

```
'Plot Data Chart
```

```
mm% = m + 1 'Yes, m+1 poles with m gaps
CALL LinePlotData(xdata(), accufi(), mm%, YELLOW, DASHEDLN)
CALL LinePlotData(xdata(), ydata0(), mm%, WHITE, SOLIDLN)
CALL LinePlotData(xdata(), ydata1(), mm%, WHITE, DASHEDLN)
CALL LinePlotData(xdata(), ydata2(), mm%, YELLOW, SOLIDLN)
IF ONOFF$(3) = "ON " THEN
CALL LinePlotData(xdata(), ydata3(), mm%, LIGHTMAGENTA, SOLIDLN)
END IF
IF ONOFF$(4) = "ON " THEN
CALL LinePlotData(xdata(), ydata4(), mm%, LIGHTGREEN, SOLIDLN)
END IF
IF ONOFF$(5) = "ON " THEN
CALL LinePlotData(xdata(), ydata5(), mm%, LIGHTCYAN, SOLIDLN)
```

```
END IF
IF ONOFF$(6) = "ON " THEN
CALL LinePlotData(xdata(), ydata6(), mm%, LIGHTRED, SOLIDLN)
END IF

      'Print Current Values in Bottom Window
CALL SetCurrentWindow(win3)
CALL ClearWindow
CALL BorderCurrentWindow(YELLOW)

selectcolor (WHITE)
CALL RealToString(y0, 2, 7, xstr$)
xstr$ = "S0 = " + xstr$
CALL LabelGraphWindow(50!, 800!, xstr$, LEFTTEXT, LEFTTEXT)

selectcolor (WHITE)
CALL RealToString(y1, 2, 7, xstr$)
xstr$ = "S1 = " + xstr$
CALL LabelGraphWindow(300!, 800!, xstr$, LEFTTEXT, LEFTTEXT)

selectcolor (YELLOW)
CALL RealToString(y2, 2, 7, xstr$)
xstr$ = "S2 = " + xstr$
CALL LabelGraphWindow(550!, 800!, xstr$, LEFTTEXT, LEFTTEXT)

selectcolor (LIGHTMAGENTA)
CALL RealToString(Y3, 2, 7, xstr$)
xstr$ = "S3 = " + xstr$
CALL LabelGraphWindow(800!, 800!, xstr$, LEFTTEXT, LEFTTEXT)

selectcolor (LIGHTGREEN)
CALL RealToString(Y4, 2, 7, xstr$)
xstr$ = "S4 = " + xstr$
CALL LabelGraphWindow(50!, 600!, xstr$, LEFTTEXT, LEFTTEXT)

selectcolor (LIGHTCYAN)
CALL RealToString(Y5, 2, 7, xstr$)
xstr$ = "S5 = " + xstr$
CALL LabelGraphWindow(300!, 600!, xstr$, LEFTTEXT, LEFTTEXT)

selectcolor (LIGHTRED)
CALL RealToString(Y6, 2, 7, xstr$)
xstr$ = "S6 = " + xstr$
CALL LabelGraphWindow(550!, 600!, xstr$, LEFTTEXT, LEFTTEXT)

selectcolor (WHITE)
CALL RealToString(Y7, 2, 7, xstr$)
```

```
xstr$ = "S7 = " + xstr$  
CALL LabelGraphWindow(800!, 600!, xstr$, LEFTTEXT, LEFTTEXT)
```

```
selectcolor (YELLOW)  
xstr$ = LEFT$(RIGHT$(luxtron$, 13), 11) + " C"  
xstr$ = "Accufiber Temperature= " + xstr$  
CALL LabelGraphWindow(275!, 300!, xstr$, LEFTTEXT, LEFTTEXT)
```

```
CALL selectcolor(WHITE)  
CALL LabelGraphWindow(350!, 100!, "Press <Q> to quit", LEFTTEXT, LEFTTEXT)
```

```
selectcolor (WHITE)  
xstr$ = "" + dnew$  
CALL LabelGraphWindow(50!, 300!, xstr$, LEFTTEXT, LEFTTEXT)  
xstr$ = "" + tnew$  
CALL LabelGraphWindow(50!, 100!, xstr$, LEFTTEXT, LEFTTEXT)
```

```
xstr$ = "" + dold$  
CALL LabelGraphWindow(800!, 300!, xstr$, LEFTTEXT, LEFTTEXT)  
xstr$ = "" + told$  
CALL LabelGraphWindow(800!, 100!, xstr$, LEFTTEXT, LEFTTEXT)
```

```
CALL SetCurrentWindow(win2)
```

```
LOOP UNTIL UCASE$(INKEY$) = "Q"
```

```
start:
```

```
CALL CloseSEGraphics      'Leave SE Graph Lib  
END  
CALL LeaveDap             'Terminate DAP communication  
END
```


Appendix E.2 HILOT

```
' HILOT.BAS
,
' Summitec Corporation - High Temperature Calibration Furnace System
,
' HILOT.BAS is the second program written for the High Temperature
' Calibration Furnace System, a product of Summitec Corporation.
' This program will read and plot the data collected from HISCAN.BAS,
' the other program associated with the Summitec's HTCFS.
,
' To execute the program, user may:
'     login proper directory,
'     type HILOT,
'     provide the \path\ and filename, and
'     follow screen menu
' to view segments of data at specified temperature ranges.
,
' To modify the program, user must compile and link before execution,
'     copy hiplot.bas templot.bas
'     qb templot
'     bc templot
'     link templot,,,qb+dapio+qb006\qb006
,
,
'SINCLUDE: 'DAPIO.INC'

'SINCLUDE: '\qb006\GRAFTYPE.BAS'

DECLARE SUB GetMaxCoords (X%, y%)
DECLARE SUB DefGraphWindow (x1%, y1%, x2%, y2%, win%)
DECLARE SUB selectcolor (c%)
DECLARE SUB InitSEGraphics (mode%, plotmode%)
DECLARE SUB SetCurrentWindow (win%)
DECLARE SUB ClearWindow ()
DECLARE SUB SetAxesType (PlotTypeX%, PlotTypeY%)
DECLARE SUB SetViewBackground (c%)
DECLARE SUB ScalePlotArea (x1!, y1!, x2!, y2!)
DECLARE SUB SetXYIntercepts (x1!, y1!)
DECLARE SUB DrawXAxis (TicSpace!, dir%)
DECLARE SUB LabelXAxis (NthTic%, dir%)
DECLARE SUB LabelXAxisWithStrings (NthTic%, TicStrings$, NumStrings%, dir%)
DECLARE SUB DrawYAxis (TicSpace!, dir%)
DECLARE SUB LabelYAxis (NthTic%, dir%)
DECLARE SUB LabelYAxisWithStrings (NthTic%, TicStrings$, NumStrings%, dir%)
DECLARE SUB LinePlotData (datax!(), datay!(), numdat%, newcolor%, linestyle%)
```

```
DECLARE SUB ScatterPlotData (Xdata!(), ydata!(), numdat%, scatcol%, markType%)
DECLARE SUB TitleWindow (wintitle$)
DECLARE SUB TitleXAxis (Xtitle$, dir%)
DECLARE SUB TitleYAxis (Ytitle$, dir%)
DECLARE SUB BarGraphData (datax!(), datay!(), numdat%, barwid!, newcolor%, htch%, just%, VF%)
DECLARE SUB CloseSEGraphics ()
DECLARE SUB Histo (xvals!(), bins!(), histog!(), numdat%, numbins%, sortflag%, percent%)
DECLARE SUB selectcolor (c%)
DECLARE SUB BorderCurrentWindow (c%)
DECLARE FUNCTION MonoCRT% ()
DECLARE SUB SETPARAM (PARAMNUMBER%, PARAMETERS$)
```

```
DIM onoff$(0 TO 7)
DIM TCID$(0 TO 7)
DIM TCTYPES$(0 TO 7)
DIM sk%(0 TO 7)
FOR m = 0 TO 7
    sk%(m) = 0
NEXT m
COLOR YELLOW, green      'Screen for LOGO
CLS
LOCATE 10, 10
PRINT "High Temperature Calibration Furnace System"
COLOR YELLOW, green
LOCATE 20, 50
PRINT "Summitec Corporation"
SLEEP 5
COLOR WHITE, black
CLS
INPUT "Enter \PATH\ and NAME of data file: ", file$
```

```
nt = 3000
```

```
DIM Xdata(0 TO nt)
DIM ydata0(0 TO nt)
DIM ydata1(0 TO nt)
DIM ydata2(0 TO nt)
DIM ydata3(0 TO nt)
DIM ydata4(0 TO nt)
DIM ydata5(0 TO nt)
DIM ydata6(0 TO nt)
DIM ydata7(0 TO nt)
DIM accufi(0 TO nt)
DIM xlabel$(0 TO 10)
DIM ylabel$(0 TO 10)
```

```
ngap = 10      'Minimum interval Range
nset = 2       'Minimum Temperature Range
Xdata(0) = 0
accufi(0) = 400

                        'Read in data via #3
OPEN file$ FOR INPUT AS #3 ' diskfile for input

DO                        'Read Header
  LINE INPUT #3, d$
  PRINT d$
LOOP UNTIL INSTR(d$, "ON") <> 0 OR INSTR(d$, "OFF") <> 0

m = 0
DO                        'Read On/Off Switches
  IF INSTR(d$, "ON") <> 0 THEN
    onoff$(m) = "ON "
  ELSE
    onoff$(m) = "OFF"
  END IF
  LINE INPUT #3, d$
  PRINT d$
  m = m + 1
LOOP UNTIL INSTR(d$, "ON") = 0 AND INSTR(d$, "OFF") = 0

DO                        'Read Thermocouple Types
  LINE INPUT #3, d$
  PRINT d$
LOOP UNTIL INSTR(d$, "8-Type L") <> 0

PRINT " "
PRINT " "
PRINT "    ***   Please wait while reading data   ***"
PRINT " "
PRINT " "

m = 0                        'Read data set:
DO
  IF NOT EOF(3) THEN        'Read TIME data collected
    DO
      LINE INPUT #3, d$
      LOOP UNTIL INSTR(d$, "The time is") <> 0
      m = m + 1              'Read Thermocouple Data
      Xdata(m) = m
      INPUT #3, ydata0(m), ydata1(m), ydata2(m), ydata3(m)
      INPUT #3, ydata4(m), ydata5(m), ydata6(m), ydata7(m)
    END IF
```

```
'Read Fiber Optics data
IF NOT EOF(3) THEN
  DO
    LINE INPUT #3, a$
    LOOP UNTIL INSTR(a$, " C") <> 0
    a$ = LEFT$(a$, LEN(a$) - 1)
    DO
      a$ = RIGHT$(a$, LEN(a$) - 1)
      LOOP UNTIL INSTR(a$, " ") = 1
      accufi(m) = VAL(a$)
    END IF
  LOOP UNTIL EOF(3)
mt% = m

PRINT " " 'Specify X-Y ranges
PRINT "Specify X-Y Range, total data points = ", mt%
DO
  INPUT "Enter Xmin, Xmax ( Diff >= 10 ): ", Xmin, Xmax
  LOOP UNTIL Xmax >= Xmin + ngap
DO
  INPUT "Enter Ymin, Ymax ( Diff >= 2 ): ", Ymin, Ymax
  LOOP UNTIL Ymax >= Ymin + nset
PRINT " "

CALL InitSEGraphics(-3, 0) 'Define Window Dimension
CALL GetMaxCoords(maxX%, maxY%)
CALL DefGraphWindow(1, maxY% / 12, maxX%, maxY% * 11 / 12, win2)
CALL DefGraphWindow(maxX% / 4, maxY% * 11 / 12 + 1, maxX% * 3 / 4, maxY%, win3)
CALL SetCurrentWindow(win2)

quit = 0 'Start plotting
DO
  CALL ClearWindow
  CALL SetAxesType(AXLINEAR, AXLINEAR)
  IF (NOT MonoCRT%) THEN CALL SetViewBackground(black)

  Xmin = INT(Xmin)
  Xmax = INT(Xmax)
  Xdif10% = (Xmax - Xmin) / 10
  Xmax = Xmin + Xdif10% * 10

  Y10min = INT(Ymin * 10)
  Y10max = INT(Ymax * 10)
  Y2dif% = (Y10max - Y10min) / 5
  Ymin = Y10min / 10
  Ymax = Ymin + Y2dif% / 2
```

```
nx = Xdif10%  
ny = (Y2dif% / 2) / 20
```

```
FOR jj% = 0 TO 10  
  xlabel$(jj%) = STR$(Xmin + jj% * nx) + " "  
  ylabel$(jj%) = STR$(Ymin + jj% * 2 * ny)  
NEXT jj%
```

```
CALL ScalePlotArea(Xmin!, Ymin!, Xmax!, Ymax!)  
CALL SetXYIntercepts(Xmin!, Ymin!)  
CALL selectcolor(WHITE)
```

```
CALL DrawXAxis(nx!, AXBOTTOM)  
CALL DrawYAxis(ny!, AXLEFT)  
'CALL LabelXAxis(1, AXBOTTOM)  
'CALL LabelYAxis(2, AXLEFT)  
CALL LabelXAxisWithStrings(1, xlabel$, 11, AXBOTTOM)  
CALL LabelYAxisWithStrings(2, ylabel$, 11, AXLEFT)  
CALL selectcolor(WHITE)  
CALL TitleWindow("Raw Data file : " + file$)  
CALL TitleXAxis("Number of Sampling", AXBOTTOM)  
CALL TitleYAxis("Temperature in Celsius", AXLEFT)
```

```
mm% = Xmax + 1          'Plot Line Chart  
IF sk%(7) = 0 THEN  
  CALL LinePlotData(Xdata(), accufi(), mm%, YELLOW, DASHEDLN)  
END IF  
IF sk%(0) = 0 THEN  
  CALL LinePlotData(Xdata(), ydata0(), mm%, WHITE, SOLIDLN)  
END IF  
IF sk%(1) = 0 THEN  
  CALL LinePlotData(Xdata(), ydata1(), mm%, WHITE, DASHEDLN)  
END IF  
IF sk%(2) = 0 THEN  
  CALL LinePlotData(Xdata(), ydata2(), mm%, YELLOW, SOLIDLN)  
END IF  
IF onoff$(3) = "ON " AND sk%(3) = 0 THEN  
  CALL LinePlotData(Xdata(), ydata3(), mm%, LIGHTMAGENTA, SOLIDLN)  
END IF  
IF onoff$(4) = "ON " AND sk%(4) = 0 THEN  
  CALL LinePlotData(Xdata(), ydata4(), mm%, LIGHTGREEN, SOLIDLN)  
END IF  
IF onoff$(5) = "ON " AND sk%(5) = 0 THEN  
  CALL LinePlotData(Xdata(), ydata5(), mm%, LIGHTCYAN, SOLIDLN)  
END IF
```

```
IF onoff$(6) = "ON " AND sk%(6) = 0 THEN
CALL LinePlotData(Xdata(), ydata6(), mm%, LIGHTRED, SOLIDLN)
END IF
```

```
CALL SetCurrentWindow(win3) 'Print Color Code for Each Line
CALL ClearWindow
```

```
CALL BorderCurrentWindow(YELLOW)
```

```
selectcolor (WHITE)
xstr$ = "S0 "
CALL LabelGraphWindow(50!, 500!, xstr$, LEFTTEXT, LEFTTEXT)
```

```
selectcolor (WHITE)
xstr$ = "S1 "
CALL LabelGraphWindow(175!, 500!, xstr$, LEFTTEXT, LEFTTEXT)
```

```
selectcolor (YELLOW)
xstr$ = "S2 "
CALL LabelGraphWindow(300!, 500!, xstr$, LEFTTEXT, LEFTTEXT)
```

```
selectcolor (LIGHTMAGENTA)
xstr$ = "S3 "
CALL LabelGraphWindow(425!, 500!, xstr$, LEFTTEXT, LEFTTEXT)
```

```
selectcolor (LIGHTGREEN)
xstr$ = "S4 "
CALL LabelGraphWindow(550!, 500!, xstr$, LEFTTEXT, LEFTTEXT)
```

```
selectcolor (LIGHTCYAN)
xstr$ = "S5 "
CALL LabelGraphWindow(675!, 500!, xstr$, LEFTTEXT, LEFTTEXT)
```

```
selectcolor (LIGHTRED)
xstr$ = "S6 "
CALL LabelGraphWindow(800!, 500!, xstr$, LEFTTEXT, LEFTTEXT)
```

```
selectcolor (YELLOW)
xstr$ = "OF"
CALL LabelGraphWindow(925!, 500!, xstr$, LEFTTEXT, LEFTTEXT)
```

```
CALL SetCurrentWindow(win2)
      'Option Plot Specifications
```

```
PRINT " <Q> to quit, <X> to change X scale, <Y> to change Y scale, <S> to skip a line"
```

```
DO
  o$ = INPUT$(1)
  o$ = UCASE$(o$)
LOOP UNTIL o$ = "Q" OR o$ = "X" OR o$ = "Y" OR o$ = "P" OR o$ = "S"

IF o$ = "X" THEN
  DO
    INPUT " Xmin, Xmax ( Diff >= 10 ): ", Xmin, Xmax
    LOOP UNTIL Xmax >= Xmin + ngap
  ELSEIF o$ = "Y" THEN
    DO
      INPUT " Ymin, Ymax ( Diff >= 2 ): ", Ymin, Ymax
      LOOP UNTIL Ymax >= Ymin + nset
    ELSEIF o$ = "S" THEN
      'Skip a Line
      INPUT "skip S0,S1,S2,S3,S4,S5,S6,or OF : ", skip$
      skip$ = UCASE$(skip$)
      IF skip$ = "S0" THEN
        sk%(0) = 1
      ELSEIF skip$ = "S1" THEN
        sk%(1) = 1
      ELSEIF skip$ = "S2" THEN
        sk%(2) = 1
      ELSEIF skip$ = "S3" THEN
        sk%(3) = 1
      ELSEIF skip$ = "S4" THEN
        sk%(4) = 1
      ELSEIF skip$ = "S5" THEN
        sk%(5) = 1
      ELSEIF skip$ = "S6" THEN
        sk%(6) = 1
      ELSEIF skip$ = "OF" THEN
        sk%(7) = 1
      END IF
    ELSEIF o$ = "P" THEN
      'Hidden Option to Print Screen
      printerDr% = 0
      IOport% = 0
      res% = 0
      xm = 1!
      ym = 1!
      rv% = 0
      orient% = 1
      ff% = 0
      win% = 0
      CALL ScreenDump(printerDr%, IOport%, res%, xm, ym, rv%, orient%, ff%, win%, errr%)
    ELSE
      quit = 1
```

END IF
CLS 0
CALL SetCurrentWindow(win2)

LOOP UNTIL quit = 1 'End of Session

CALL CloseSEGraphics
END
END

